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# M-learning using PDA's and our supporting LOMS

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**Abstract:** *We have extended an existing e-blended learning system with an extra layer, to offer a more flexible and more effective learning process to both mobile and non-mobile students. It is possible to consult learning materials, to share and to put supporting communication applications at their disposal where, when and with each device the student likes.*

*All knowledge objects have been stored in a knowledge warehouse and will be managed by our LOMS (a knowledge object management system). Our LOMS has been extended, having now a portal for PDA access by the students.*

**Keywords:** *M-learning, PDA, LOMS, E-Mindmap*

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## 1. Introduction

The organization of knowledge as knowledge objects is a hot topic in knowledge management research. Knowledge objects have been stored in a knowledge warehouse and will be managed by a knowledge object management system (LOMS).

Learning objects have been defined as learning content items, in which is included the content document itself (or an URL of it) and the characteristics of the document formulated as metadata. By this way learning content has been organised and managed in a learning content warehouse and has been made accessible. Those learning objects should be implemented in all popular LMS (learning management systems) as e-learning modules and courses.

For mobile workers, mobile learning or m-learning is becoming popular. Mobile learning means the provision of education and training materials and courses on wireless devices: portable computers, PDA's (personal digital wireless devices), and mobile telephones. We concentrate here on the PDA, as a handheld computer.

With a PDA, a teacher, student or administrator can do amazing things: take notes, calculate, sketch ideas, collect data, access resources, manage activities and, with the right hardware, even access the Internet wirelessly. Handheld computers can offer unique benefits to students and teachers. Students can have a personal, portable device ready-at-hand for individual

or collaborative learning activities, wherever they go. Students can use handheld computers to collect data in the field, to learn vocabulary words while waiting to be picked up after soccer practice, or to self-quiz during a long car ride."

Learning materials and e-learning courses have been stored in the warehouse of learning materials. All learning systems have been built and are part of the learning object management system (LOMS).

Our learning object management system (LOMS) has functions to enter and to organise the learning objects in the warehouse and to make them available for learners and teachers using the LMS portals in which the learning process and its activities have been structured.

Our LOMS has been extended, having now a portal for PDA access by the students. Most of the LOMS student applications have been made available for users of mobile computers, the laptop and the PDA. The LOMS is now compatible for all kind of user devices, the conventional desktop PC as well as the mobile devices laptop, PDA and mobile telephone.

## 2. Mobile learning and mobile devices

Mobile learning means the provision of education and training courses on wireless devices: PDA's (personal digital wireless devices), laptops and mobile telephones.

## 2.1. The advantages

The advantages of mobile learning refer mostly to the mobile user: a great flexibility, an improved learning schedule is possible, increased productivity during dead moments and just-in-time learning. But also for the non-mobile user is the usage of mobile devices useful in a learning process, for example the supporting and communicative functions of a forum.

## 2.2. The technological challenges

On the technological side we have seen some developments that can give a boost to mobile learning. On the one hand there is the upcoming usage of GPRS and UMTS, this makes it possible to send/receive data at a higher speed. On the other hand there is a large increase of functionality and usage of mobile devices. One of the last developments is the support of TCP/IP, http-protocols within WAP2.0. This makes mobile internet applications possible and gives access to general web page formats.



Figure 1: PDA showing a list of contacts

## 2.3. Some minus points

Nevertheless they have very small screens, limited memory capacity and the large diversity of mobile devices obstruct a good learning experience. (figure 1) In the educational field we notice that the learning materials must answer to specific conditions. We will have to get around the technical restrictions so we can

create a good learning experience. The usage of video, audio, clear interfaces and divided courses must contribute to this.

Furthermore we will have to adapt the content to the needs of the mobile user. Because he has a very fragmented time schedule, we will have to be sure that the learning object are not too long. Dividing the knowledge in smaller modules offers a solution.

Another problem is the keyboard. Some advanced technological solutions have been built. (figure 2)

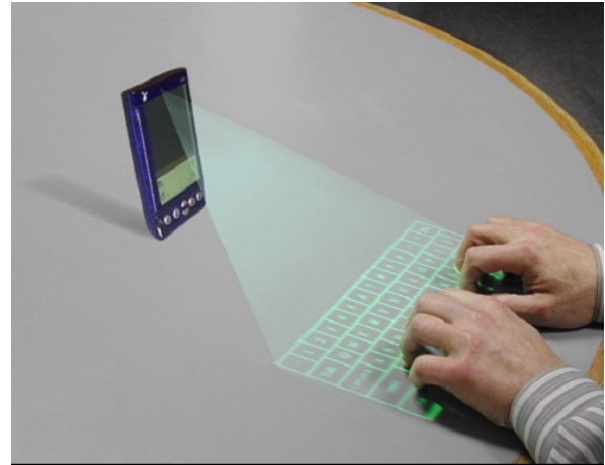


Figure 2: The simulation of a keyboard

But as a result of our research [6] on the use of PDA's in our city Hasselt we asked also for the preferential user interface. We can conclude that most people like the touch screen and the pen as a user interface.

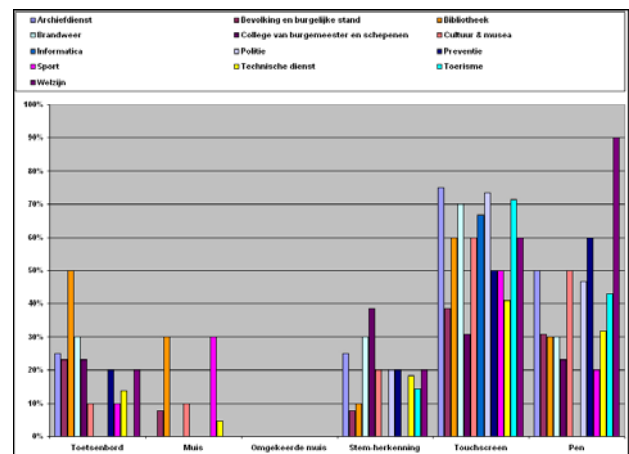


Figure 3: Preferential user interface

## 2.4. The PDA the wireless virtual learning environment of tomorrow

With a PDA, a teacher, student or administrator can do

amazing things: take notes, calculate, sketch ideas, collect data, access resources, manage activities and, with the right hardware, even access the Internet wirelessly.

Twenty-five years of research on desktop computers has shown that, when used appropriately, technology can have a beneficial impact on teaching and learning. The PEP evaluation study found that handheld computers could offer unique benefits to students and teachers. Students can have a personal, portable device ready-at-hand for individual or collaborative learning activities, wherever they go. Students can use handheld computers to collect data in the field, to learn vocabulary words while waiting to be picked up after soccer practice, or to self-quiz during a long car ride.

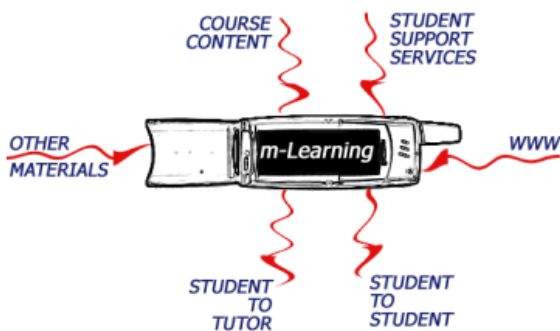


Figure 4: Wireless Virtual Learning Environment of Tomorrow

### 3. Fourth wave in computing: the evolution to mobile and me-centric computing

The fourth wave is often called pervasive or ubiquitous computing.

We are already experiencing a new wave of computing devices, such as information appliances (PDA's, computers integrated with cell phones, and small specialised info devices of diverse kinds), which allows for greater mobility of info and services.

Pervasive computing means inventing in better tools. So we have the evolution from laptop to tablet PC and to digital paper. The walls in our office will become reactive displays. Our applications have embedded intelligence via sensors.

Pervasive computing enriches objects in the real world and makes them "smart", thereby making them better tools for the people using them. This allows these devices to assist people better. By adding info about the environment and the context, these devices become better tools for the people using them.

Pervasive computing is just about inventing better tools, Me-centric computing goes a step further: the power of computing and communication will be designed into appliances that embody solutions we access and agents to which we delegate concerns. This revolution in computer usage will give the user the capability to delegate work to computers

The advances of the last years are forcing their way toward the Me-centric generation.

Some early Me-centric appliances are already popular.

We all know the airplane "auto-pilot", the cruise control in our car, the auto focus camera and the GPS-based navigation systems in our cars. In these examples technology can perform tasks for users instead of simply supporting them.

#### 3.1. Mobility and a new generation of mobile applications

Mobility is becoming a key concern for corporations worldwide. Executives are looking for an extension of the functionalities of the desktop and the availability of info on it. It has to become available on the PDA's, phones and laptops they carry and use regularly.

A new generation of mobile applications will be able to adapt themselves to the requirements of the user and will deliver context-sensitive services, for example the map service on the internet. In the future the system can receive your location as contextual info and will be able to personalise the service. The system can show the right part of the map and based on the system's knowledge about you, can show you the right restaurants, museums and where they are located

The revolution in computer usage will give the user the capability to delegate work to computers. Thus, the user accesses via the interface, (where the computing functionality starts,) to various devices and then work will be tasked from this interface to various computers, applications and intelligent agents distributed around the world on the Internet or its successors.

#### 3.2. Me-centric appliances and architecture

Tablet PC and PDA/phone combinations are Me-centric appliances. Parallel to the rise of those devices is the development of new infrastructure and standards that will make mobile and wireless computing a reality. Wireless LANs, Bluetooth, 802.11, and other technologies are rapidly evolving, facilitating connectivity and access.

The me-centric computing model holds that

inexpensive, microscopic processors and radio transceivers are embedded in everyday things thus making everything “invisibly” intelligent. Today we find them in phones, TV sets, cameras, cars, thermostats and credit cards. Tomorrow we will find them also in business cards, note pads, desks, keys, doors, shoes and wall paint. The result is an intelligent environment that integrates computing seamlessly into work and life.

## **4. Mobility learning project**

### **4.1. Accessing our LOMS (Learning Object Management System) using a PDA.**

Our main task was to build a new portal to manage the access of the student via a pocket-PC to our learning applications in LOMS. A main requirement is that all applications were available for desktop and for mobile users. The applications remain the same. Only a multiple user interface must exist. Dependent on the kind of appliance has been used, the corresponding interface will be activated automatically.

### **4.2. What do students expect from mobile internet and PDA?**

An inquiry, asking for the students opinions, has shown which mobile internet and PDA applications are attractive and relevant for them. Which applications will support the mobility of the students?

#### ***4.2.1. Availability of information about the organisation of the learning activities***

Teachers are informing students through various channels, being the e-mail, the information-board, the LMS Blackboard ...

Bringing together all the messages in one central file and make it available as mobile internet portal will improve the communication between the students and the teachers.

The academic calendar and the lectures schedules are already available. But the students want to receive a personal calendar including the planning of all planned courses and other activities, related to the courses for which they are enrolled. Furthermore the students like to find all the practical information about a certain course here. This can be the consulting hours of the teacher, the geographical location of the courseroom.

#### ***4.2.2. A central portal that combines all relevant non educational information, being all social and cultural activities and all kinds of practical information***

Sport- and cultural associations address mostly their members through various means (posters, e-mail, ...). In a central portal all news messages from all the organizations can be centralized, which will result in a broader reach with less effort. In that same portal the students want to find all the practical information they need during their studies, f.e. about transportation. The train and bus schedules can be provided online. Information about the doctor in charge and his consulting hours must be included as well.

#### ***4.2.3. Sending instant urgent messages***

All the last-minute changes can be centralised in this portal an can reach student anywhere (ex. waiting for the bus)

#### ***4.2.4. Organisation of personalised coaching***

For some lectures a personalized coaching can be organized. Students can attend or students can participate at a distance but on a planned moment.

M-learning makes this personalized coaching and accompanied chat sessions even more accessible.

#### ***4.2.5. Interaction concerning the content during the lectures***

The content or interesting statements can be evaluated already during the course via a voting system. A teacher can ask the student their opinion on a certain matter during class. This gives him instant feedback and the possibility to interact immediately. A discussion about the result of the voting can be held.

#### ***4.2.6. The learning activity can be organized as self-paced individual or team learning and distance learning is an opportunity thanks to mobile solutions***

Learning today is no longer confined to institutions such as schools and colleges. New technologies and tools offer all students greater flexibility, easier access to information and the opportunity to organize their learning activity by themselves and matching their specific needs and circumstances. One of the objectives of m-learning is to motivate the students to participate in life-long learning initiatives. Self-paced learning is often for some learners the most effective way of learning.

One of the best ways to succeed in learning is the organization of collaborative learning. All learners of a team are working together, are sharing and comparing ideas. Distance learners can do learning online. In m-learning the supporting functions are available. Students can access their schoolwork where and when they want.

### 4.3. Two prototype learning applications on PDA

A team of students in Master in business informatics developed two prototype applications, first being a personal calendar [3] and second a synchronic communication system between students and professors [4].

#### 4.3.1. A personalized agenda

Students can ask for info through various applications, being a.o. e-mail, study guide, course scheduler, information board, LMS Blackboard. Information is spread over more systems and searching for information is complex. Students ask to simplify this process by integrating those systems and by making them available via one portal.

Another problem is the general characteristic of the course scheduler. Students like to have a personal agenda available, including the official schedule of all planned activities related to the courses for which they are enrolled. In that calendar the student can make personal changes by removing some activities and by adding another ones.

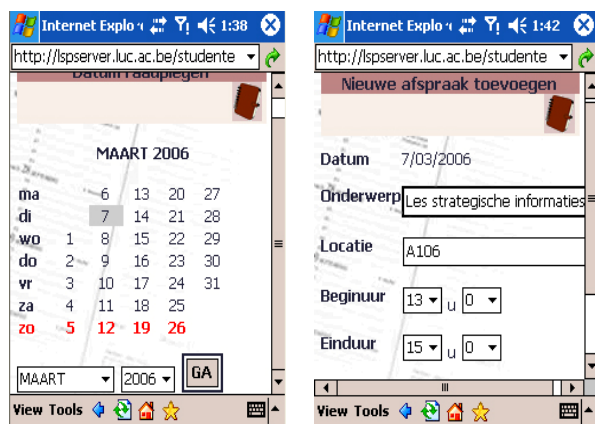


Figure 5: Personal agenda

#### 4.3.2. Synchronic communication between the professor and the students

We focus here on two types of communication. First the professor asks for feedback from the students during the course. Second is the solution of personal coaching on distance of the students by the professor.

The apprehension of the content can be evaluated during the session itself. The professor asks for the feedback of the students group and dependent of it some part of the session can be repeated. Also their opinion can be taken into account in planning some activities.

In all those cases, a voting system can help. It is an opportunity for the professor to coach online a self-paced learning session or a planned on-distance learning session.

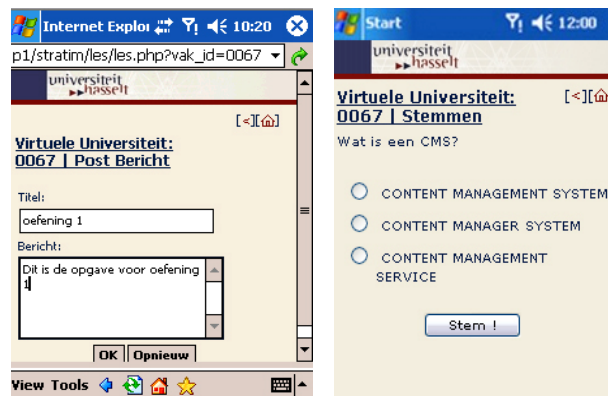


Figure 6: Voting system and online coaching

## 5. A LOMS (learning object management system) to support m-learning

The main objective of this system is to expand the distribution possibilities for learning materials and the communication facilities to users of mobile devices, being a wireless laptop or a pocket PC. We believe the learning process has to be organised as a blended learning process, in which we have a mix of traditional classroom and distance learning activities.

### 5.1. The access to learning materials and the communication using PDA's

Mobile learning (m-learning) means the access to learning materials and the communication using wireless devices: PDA's (personal digital wireless devices), laptops and mobile telephones. But m-learning is a part of blended learning, and as a consequence the system must support the access to learning materials and the communication for mobile and for non-mobile devices.

Learning materials and e-learning courses have been stored in the warehouse of learning materials. All learning systems have been built and are part of the learning object management system (LOMS).

For the moment most of the LOMS students applications have been made available for users of mobile computers, the laptop and the PDA. But the small screen of the PDA requires another interface screen. Another problem is the upload facility of files, being not compatible.

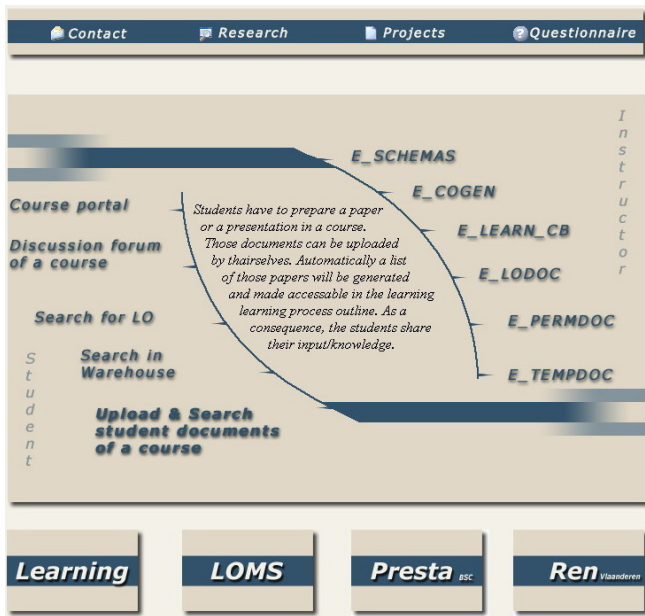


Figure 7: LOMS portal for the desktop or laptop applications

Still another problem we are trying to solve is the presentation of our learning content as e-MINDMAP LO's. The view over the e-MINDMAP is very limited.

### 5.2. Uploading of documents by students

Mainly it is the intention to make available all learning content organised as learning objects in a learning content warehouse and to have access to it using mobile and wireless devices for better support of distance learning, being part of blended learning. During the development we examined the possibilities and limitations of the different devices to make more flexible learning processes for the students.

Distance learning includes the facility of uploading files by the distant learners. It can be an assignment or a shared learning document. To store those documents we have extended the system with another layer. We call this layer the Student warehouse, it allows the student to consult information and to share information with others. This is also the layer we made available for mobile learning. The students now have the possibility to consult and share information anywhere and anytime.

The physical storage will be split in the document on the one hand and the metadata on the other hand. The metadata is stored in a data table, while the documents are categorized in a hierarchical directory structure.

### 5.3. Presentation of learning courses using EDUMAPS

As an e-learning course presentation design, we are

using the e-MINDMAP or EDUMAP concept.

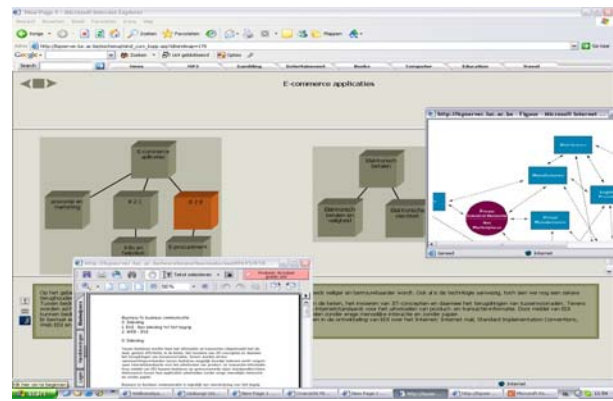


Figure 8: An example of an e-Mindmap

A PDA is not suitable to present complex e-learning course modules. Text must be limited. Multimedia components have to be imported and especially audio and video fragments can be used.

### 5.4. The extension of the Functions of the LOMS to support mobile learners

The intention of this system is mainly to make information accessible for students and by students, regardless of place and time. By making the LOMS available for mobile learning, the need for flexibility can be satisfied.

To increase the flexibility of the student, we have implemented the following applications.

An upload function for all kind of documents: This is only possible when you access the system with a desktop pc or laptop. The internet explorer of a pocket pc running windows mobile doesn't support the upload of files. So the students have the possibility to upload files trough a webpage, but only from a desktop pc. There is also a possibility to add metadata, this makes it easier to consult the documents.

Automatically saving the document and metadata in the warehouse: the uploaded files must be saved in the warehouse. The uploaded files can be Word, Excel or PDF-documents. This is because windows mobile comes standard with a version of Word and Excel. There is also a free PDF reader available on the internet.

The access to and the downloading of learning content and of the learning objects have been made possible from each of the devices. The files will be downloaded and saved on the pocket pc. And afterwards opened by

the corresponding program.

Dynamic generation of a document's page: if students want to consult or download files, the list of these documents must be up to date. This list will be automatically generated with an asp-page and it will be always up to date.

The following preset requirements have been fulfilled:

*Flexibility:* the student must have access to the learning objects at any place, at any time and using all different devices.

*Ease of use:* the whole system must be easy, logical and usable for non-technical people.

*Suitability:* We also have to take account of the limitations of each device. The use of large documents is not practical with a mobile device. The applications must be adapted to medium that will be used.

*Re-usability:* The re-usability of learning materials is a strong requirement too. That is why the metadata must be stored in a database. The documents can then be found with a search on the metadata.

## 5.5. System functions

In LOMS we distinguish 8 functions:

An index page to identify the communicating device: When a student enters the index page, there will be checked which operating system he is using. Rather then checking which browser is being used. Because Windows Mobile for pocket pc is a full operating system from Microsoft and also runs an internet explorer for surfing the internet. It is better to develop a version according to the operating system that is used.

A LOMS portal is a page that gives an overview of the different possibilities in of the LOMS. It consists of the 4 most important tools that the student can use. And a help for the people who have problems or questions regarding the LOMS.

A course portal where the students can consult course information. The course portal gives an overview of all the courses of a particular teacher. The student can choose between the different courses and consult the information at any time at any place.

An upload page for documents and learning objects: The upload of documents in a warehouse makes it possible to share documents with others. Through a web page the student can browse to the file that he wants to share. He has to enter a title and subject and some extra information, being the metadata that will be saved in a data table. By the way it will be easier to

search for the document. As stated before this is only available for the desktop pc.



Figure 9: Index page on PDA

The dynamic generation of the document's page: This page is written in ASP, it will watch a directory and every time when the page is called it will make a list of all the files that are present in the directory. So every time you call the page it will be up to date with the latest files. The forum: The communication between students and the teacher is a very important function within the learning process. A forum is one of these communication forms. Providing that it is well implemented, it will increase the interactivity between the teacher - students and between the students mutually. It allows the student to ask questions, discuss the material, and explain assignments and so on. The usage of a forum is very important for a mobile student. Because he is mostly on the road he can ask his questions on the forum.

Search and download of all files in the warehouse, including files uploaded by students and those uploaded by staff members. All text documents, pictures, sound files, movies, ... can be managed.

Search for LO: Search for e-MINDMAPS and for e-learning course modules and courses.

In case of PDA we will change the presentation format, taking into account the limitations of the small display.



Help function: Because some people have limited knowledge of informatics it is really necessary to have a help function. Every part of the Student warehouse is explained here. This is of course the same for the mobile and non-mobile user.

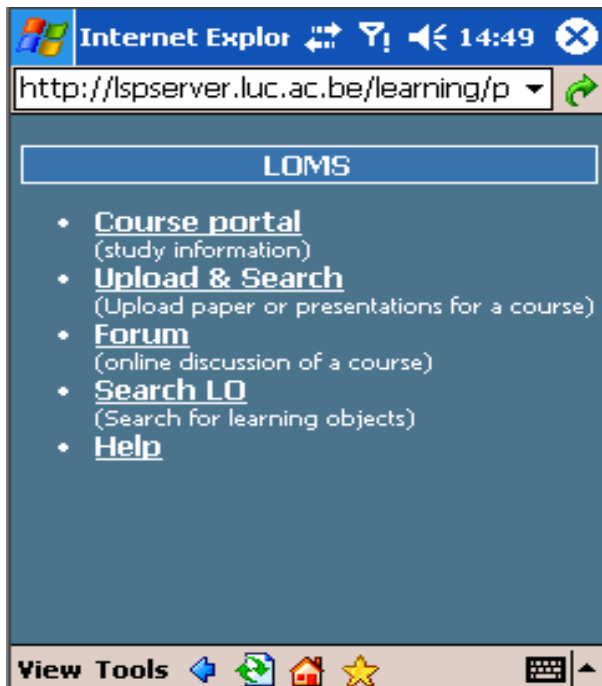


Figure 10: PDA LOMS portal

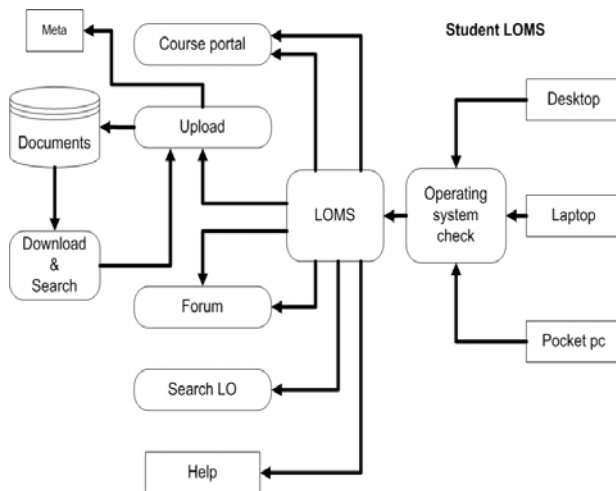


Figure 11: Student LOMS

## 6. Conclusion and future work

We have extended an existing e-blended learning system with an extra layer, to offer a more flexible and more effective learning process to both mobile and

non-mobile students. They have now the possibility to consult learning materials, to share and to put supporting communication applications at their disposal where, when and with each device the student likes.

We tried to take into consideration the properties of a well-structured learning environment and to take into account the limitations of the different user devices. In this project we rather approached m-learning as a new distribution facility and we didn't focus on the learning concept. It's in fact an e-learning application that's made available in a mobile format. This way of mobile working results in more flexibility for the learner and in the increase of e-learning opportunities. M-learning is a part of the blended mix that is harmonized with the needs of the mobile student.

The main objective was to make learning material and information accessible for the mobile students, transforming the LOMS to become compatible for all kind of user devices, the conventional desktop PC as well as the mobile devices laptop, PDA and mobile telephone. The learning materials of the student warehouse are accessible from every device. The uploading and converting of the documents elapses entirely automatic, this makes it possible for the students to easily add documents to the student warehouse.

This project shows us that mobile devices can extend a learning environment and increase the flexibility of the learning process

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